individual's physical toil of providing himself with the necessities of existence in order that hand and brain may be set free for some higher order of activity.

Our age has initiated a rationalisation of industry based on the kind of working partnership between manual and mechanical production we call standardisation which is already having direct repercussions on building. There can be no doubt that the systematic application of standardisation to housing would effect enormous economies—so enormous, indeed, that it is impossible to estimate their extent at present.

Standardisation is not an impediment to the development of civilisation, but, on the contrary, one of its immediate prerequisites. A standard may be defined as that simplified practical exemplar of anything in general use which embodies a fusion of the best of its anterior forms—a fusion preceded by the elimination of the personal content of their designers and all otherwise ungeneric or non-essential features. Such an impersonal standard is called a " norm," a word derived from a carpenter's square.

The fear that individuality will be crushed out by the growing " tyranny " of standardisation is the sort of myth which cannot sustain the briefest examination. In all great epochs of history the existence of standards—that is the conscious adoption of type-forms—has been the criterion of a polite and well-ordered society; for it is a commonplace that repetition of the same things for the same purposes exercises a settling and civilising influence on men's minds.

As the basic cellular unit of that larger unit the street, the dwelling-house represents a typical group-organism. The uniformity of the cells whose multiplication by streets forms the still larger unit of the city therefore calls for formal expression. Diversity in their sizes provides the necessary modicum of variation, which in turn promotes natural competition between dissimilar types developing side by side. The most admired cities of the past are conclusive proof that the reiteration of " typical " (i.e., typified) buildings notably enhances civic dignity and coherence. As a maturer and more final model than any of the individual prototypes merged in it, an accepted standard is always a formal common denominator of a whole period. The unification of architectural components would have the salutary effect of imparting that homogeneous character to our towns which is the distinguishing mark of a superior urban culture. A prudent limitation of variety to a few standard types of buildings increases their quality and decreases their cost, thereby raising the social level of the population as a whole. Proper respect for tradition will find a truer echo in these than in the miscellaneous solutions of an often arbitrary and aloof individualism because the greater communal utility of the former embodies a deeper architectural significance. The concentration of essential qualities in standard types presupposes methods of unprecedented industrial potentiality, which entail capital outlay on a scale that can only be justified by mass-production.

## RATIONALISATION.

Building, hitherto an essentially manual trade, is already in course of transformation into an organised industry. More and more work that used to be done on the scaffolding is now carried out under factory conditions far away from the site. The dislocation which the seasonal character of building operations causes employers and employed alike—as, indeed, the community at large—is being gradually overcome. Continuous activity throughout the year will soon become the rule instead of the exception.

And just as fabricated materials have been evolved which are superior to natural ones in accuracy and uniformity, so modern practice in house construction is increasingly approximating to the successive stages of a manufacturing process. We are approaching a state of technical proficiency when it will become possible to rationalise buildings and mass-produce them in factories by resolving their structure into a number of component parts. Like boxes of toy bricks, these will be assembled in various formal compositions in a dry state: which means that building will definitely cease to be dependent on the weather. Ready-made houses of solid fireproof construction, that can be delivered fully equipped from stock, will ultimately become one of the principal products of industry. Before this is practicable, however, every part of the house—floor-beams, wall-slabs, windows, doors, staircases and fittings—will have to be normed. The repetition of standardised parts, and the use of identical materials in different buildings, will have the same sort of co-ordinating and sobering effect on the aspect of our towns as uniformity of type in modern attire has in social life. But that will in no sense restrict the architect's freedom of design. For although every house and block of flats will bear the unmistakable impress of our age, there will always remain, as in the clothes we wear, sufficient scope for the individual to find expression for his own personality. The net result should be a happy architectonic combination of maximum standardisation and maximum variety. . . . . .

Dry assembly offers the best prospects because (to take only one of its advantages) moisture in one form or another is the principal obstacle to economy in masonry or brick construction (mortar joints). Moisture is the direct cause of most of the weaknesses of the old methods of building. It leads to badly fitting joints, warping and staining, unforeseen piecework, and serious loss of time and money through delays in drying. By eliminating this factor, and so assuring the perfect interlocking of all component parts, the pre-fabricated house makes it possible to guarantee a fixed price and a definite period of construction. Moreover the use of reliable modern materials enables the stablity and insulation of a building to be increased and its weight and bulk decreased. A pre-fabricated house can be loaded on to a couple of lorries at the factory—walls, floors, roof, fittings and all—conveyed to the site, and put together in next to no time regardless of the season of the year.

The outstanding concomitant advantages of rationalised construction are superior economy and an enhanced standard of living. Many of the things that are regarded as luxurious to-day will be standard fitments in the homes of to-morrow.

So much for technique!—But what about beauty?

The New Architecture throws open its walls like curtains to admit a plenitude of fresh air, daylight and sunshine. Instead of anchoring buildings ponderously into the ground with massive foundations, it poises them lightly, yet firmly, upon the face of the earth; and bodies itself forth, not in stylistic imitation or ornamental frippery, but in those simple and sharply modelled designs in which every part merges naturally into the comprehensive volume of the whole. Thus its aesthetic meets our material and psychological requirements alike.

For unless we choose to regard the satisfaction of those conditions which can alone animate, and so humanise, a room—spatial harmony, repose, proportion—as an ideal of some higher order, architecture cannot be limited to the fulfilment of its structural function. . . . . .

This idea of the fundamental unity underlying all branches of design was my guiding inspiration in founding the original Bauhaus. During the war I had been summoned to an audience with the Grand Duke of Sachsen-Weimar-Eisenach to discuss my taking over the Weimar School of Arts and Crafts (Grossherzogliche Kunstgewerbeschule) from the distinguished Belgian architect, Henri Van de Velde, who had himself suggested that I should be his successor. Having asked for, and been accorded, full powers in regard to reorganisation I assumed control of the Weimar School of Arts and Crafts, and also of the Weimar Academy of Fine Art (Grossherzogliche Hochschule für Bildende Kunst), in the spring of 1919. As a first step towards the realisation of a much wider plan—in which my primary aim was that the principle of training the individual's natural capacities to grasp life as a whole, a single cosmic entity, should form the basis of instruction throughout the school instead of in only one or two arbitrarily " specialised " classes—I amalgamated these institutions into a Hochschule für Gestaltung, or High School for Design, under the name of Das Staatliche Bauhaus Weimar.

In carrying out this scheme I tried to solve the ticklish problem of combining imaginative design and technical proficiency. That meant finding a new and hitherto non-existent type of collaborator who could be moulded into being equally proficient in both. As a safeguard against any recrudescence of the old dilettante handicraft spirit I made every pupil (including the architectural students) bind himself to complete his full legal term of apprenticeship in a formal letter of engagement registered with the local trades council. I insisted on manual instruction, not as an end in itself, or with any idea of turning it to incidental account by actually producing handicrafts, but as providing a good all-round training for hand and eye, and being a practical first step in mastering industrial processes.

The Bauhaus workshops were really laboratories for working out practical new designs for present-day articles and improving models for mass-production. To create type-forms that would meet all technical, aesthetic and commercial demands required a picked staff. It needed a body of men of wide general culture as thoroughly versed in the practical and mechanical sides of design as in its theoretical and formal laws. Although most parts of these prototype models had naturally to be made by hand, their constructors were bound to be intimately acquainted with factory methods of production and assembly, which differ radically from the practices of handicraft. It is to its intrinsic particularity that each different type of machine owes the " genuine stamp " and " individual beauty " of its products. Senseless imitation of hand-made goods by machinery infallibly bears the mark of a makeshift substitute. The Bauhaus represented a school of thought which believes that the difference between industry and handicraft is due, far less to the different nature of the tools employed in each, than to subdivision of labour in the one and undivided control by a single workman in the other. Handicrafts and industry may be regarded as opposite poles that are gradually approaching each other. The former have already begun to change their traditional nature. In the future the field of handicrafts will be found to lie mainly in the preparatory stages of evolving experimental new type-forms for mass-production.

There will, of course, always be talented craftsmen who can turn out individual designs and find a market for them. The Bauhaus, however, deliberately concentrated primarily on what has now become a work of paramount urgency: to avert mankind's enslavement by the machine by giving its products a content of reality and significance, and so saving the home

from mechanistic anarchy. This meant evolving goods specifically designed for mass-production. Our object was to eliminate every drawback of the machine without sacrificing any one of its real advantages. We aimed at realising standards of excellence, not creating transient novelties. . . . . .

The art of building is contingent on the co-ordinated team-work of a band of active collaborators whose orchestral co-operation symbolises the co-operative organism we call society. Architecture and design in a general sense are consequently matters of paramount concern to the nation at large. There is a widespread heresy that art is just a useless luxury. This is one of our fatal legacies from a generation which arbitrarily elevated some of its branches above the rest as the " Fine Arts," and in so doing robbed all of their basic identity and common life. The typical embodiment of the l'art pour l'art mentality, and its chosen instrument, was " the Academy." By depriving handicrafts and industry of the informing services of the artist the academies drained them of their vitality, and brought about the artist's complete isolation from the community. Art is not one of those things that may be imparted. Whether a design be the outcome of knack or creative impulse depends on individual propensity. But if what we call art cannot be taught or learnt, a thorough knowledge of its principles and of sureness of hand can be. Both are as necessary for the artist of genius as for the ordinary artisan. . . . . .

Thus the Bauhaus was inaugurated with the specific object of realising a modern architectonic art, which, like human nature, should be all-embracing in its scope. Within that sovereign federative union all the different " arts " (with the various manifestations and tendencies of each)—every branch of design, every form of technique—could be co-ordinated and find their appointed place. Our ultimate goal, therefore, was the composite but inseparable work of art, the great building, in which the old dividing-line between monumental and decorative elements would have disappeared for ever.

The quality of a man's creative work depends on a proper balance of his faculties. It is not enough to train one or other of these, since all alike need to be developed. That is why manual and mental instruction in design were given simultaneously.

The actual curriculum consisted of:

(1) Practical Instruction in the handling of Stone, Wood, Metal, Clay, Glass, Pigments, Textile-Looms; supplemented by lessons in the use of Materials and Tools, and a grounding in Book-Keeping, Costing and the Drawing-Up of Tenders: and

(2) Formal Instruction under the following heads:

(a) Aspect

The Study of Nature
The Study of Materials

(b) Representation

The Study of Plane Geometry
The Study of Construction
Draughtsmanship
Model-Making

(c) Design

The Study of Volumes
The Study of Colours
The Study of Composition

supplemented by lectures on all branches of art (both ancient and modern) and science (including elementary biology and sociology).

The full course covered three periods:

(1) Preparatory Instruction, lasting six months, which consisted of elementary training in design and experiments with different materials in the special Beginners' Workshop.

(2) Technical Instruction (supplemented by more advanced instruction in design) as a legally bound apprentice in one of the Training Workshops. This lasted three years, at the end of which the pupil (if proficient enough) obtained his Journeyman's Certificate either from the local trades council or the Bauhaus itself.

(3) Structural Instruction for especially promising pupils, the duration of which varied according to the circumstances and talents of the individual concerned. This consisted of an alternation between manual work on actual building sites and theoretic training in the Research Department of the Bauhaus, which amplified the Practical and Formal Instruction he had already received. At the end of his Structural Instruction the pupil (if proficient enough) obtained his Master-Builder's Diploma either from the local trades council or the Bauhaus itself. . . . . .

## STRUCTURAL INSTRUCTION.

As has already been indicated, only fully qualified apprentices were considered sufficiently mature for active collaboration in building; and only the pick of them were admitted to our Research Station and the Designing Studio attached to it. These chosen few were also given access to all the different workshops so as to gain insight into branches of technique other than their own. Their practical training for co-operative work was always on the scaffolding of an actual building-site, but its nature varied according to the opportunities afforded by the outside contracts which the Bauhaus happened to have on hand at the moment. This enabled them to learn the correlation of everything that comes within the scope of building practice while earning their keep. In so far as our curriculum did not provide finishing courses in the theoretical side of the more specialised branches of engineering—such as steel and concrete construction, heating, plumbing, etc. —or advanced statics, mechanics and physics, it was usually found advisable to let the most promising of the architectural pupils round off their studies by attending complementary classes at various technical institutes. As a matter of principle every apprentice, on completing his training, was encouraged to go and work for a time in a factory to familiarise himself with industrial machinery and acquire business experience.

The prime essential for fruitful collaboration on the part of our pupils was a complete understanding of the aims that have inspired the New Architecture.

During the course of the last two or three generations architecture degenerated into a florid aestheticism, as weak as it was sentimental, in which the art of building became synonymous with meticulous concealment of the verities of structure under a welter of heterogeneous ornament. Bemused with academic conventions, architects lost touch with the rapid progress of technical developments and let the planning of our towns escape them. Their " architecture " was that which the Bauhaus emphatically rejected. A modern building should derive its architectural significance solely from the vigour and consequence of its own organic proportions. It must be true to itself, logically

transparent and virginal of lines or trivialities, as befits a direct affirmation of our contemporary world of mechanisation and rapid transit. The increasingly daring lightness of modern constructional methods has banished the crushing sense of ponderosity inseparable from the solid walls and massive foundations of masonry. And with its disappearance the old obsession for the hollow sham of axial symmetry is giving place to the vital rhythmic equilibrium of free asymmetrical grouping.

The direct affinity between the tight economy of space and material in industry and structures based on these principles is bound to condition the future planning of our towns. It is therefore the primary duty of everyone who aspires to be a builder to grasp the significance of the New Architecture and realise the factors which have determined its characteristics: a manifold simplicity arrived at by deliberate restriction to certain basic forms used repetitively; and the structural sub-division of buildings according to their nature, and that of the streets they face.

This was at once the limit of our Structural Instruction and the culminating point of the entire Bauhaus teaching. Any pupil who could prove he had thoroughly absorbed the whole of it and evinced adequate technical proficiency received his Master-Builder's Diploma.

What we preached in practice was the common citizenship of all forms of creative work, and their logical interdependence on one another in the modern world. We wanted to help the formal artist to recover the fine old sense of design and execution being one, and make him feel that the drawing-board is merely a prelude to the active joy of fashioning. Building unites both manual and mental workers in a common task. Therefore all alike, artist as artisan, should have a common training; and since experimental and productive work are of equal practical importance the basis of that training should be broad enough to give every kind of talent an equal chance. As varieties of talent cannot be distinguished before they manifest themselves, the individual must be able to discover his proper sphere of activity in the course of his own development. Naturally the great majority will be absorbed by the building trades, industry, etc. But there will always be a small minority of outstanding ability whose legitimate ambitions it would be folly to circumscribe. As soon as this élite has finished its communal training it will be free to concentrate on individual work, contemporary problems, or that inestimably useful speculative research to which humanity owes the sort of values stockbrokers call " futures." And since all these commanding brains will have been through the same industrial mill they will know, not only how to make industry adopt their improvements and inventions, but also how to make the machine the vehicle of their ideas. Men of this stamp are sure to be eagerly sought after.

The Bauhaus felt it had a double moral responsibility: to make its pupils fully conscious of the age they were living in; and to train them to turn their native intelligence, and the knowledge they received, to practical account in the design of type-forms which would be the direct expression of that consciousness.

As our struggle with prevailing ideas proceeded, the Bauhaus was able to clarify its own aims in the process of getting to grips with the problem of design from every angle and formulating its periodic discoveries. Our guiding principle was that artistic design is neither an intellectual nor a material affair, but simply an integral part of the stuff of life. Further, that the revolution in aesthetics has given us fresh insight into the meaning of design, just as the mechanisation of industry has provided new tools for its realisation. Our ambition was to rouse the creative artist from his other-worldliness and reintegrate him into the workaday world of realities; and at the same time

to broaden and humanise the rigid, almost exclusively material, mind of the business man. Thus our informing conception of the basic unity of all design in relation to life was in diametrical opposition to that of " art for art's sake," and the even more dangerous philosophy it sprang from: business as an end in itself.

This explains our (by no means exclusive) concentration on the design of technical products, and the organic sequence of their processes of manufacture, which gave rise to an erroneous idea that the Bauhaus had set itself up as the apotheosis of rationalism. In reality, however, we were far more preoccupied with exploring the territory that is common to the formal and technical spheres, and defining where they cease to coincide. The standardisation of the practical machinery of life implies no robotisation of the individual, but, on the contrary, the unburdening of his existence from much unnecessary dead-weight so as to leave him freer to develop on a higher plane. Efficient and well-oiled machinery of daily life cannot of course constitute an end in itself, but it at least forms a point of departure for the acquisition of a maximum of personal freedom and independence. An intellectual economy naturally takes longer to perfect than a material one, since it requires more knowledge and mental self-discipline. Here, at the focal point where civilisation and culture meet, a clearer light is shed on the fundamental difference between an ordinary commercial product, the humble output of a calculating brain, and the work of art, the fruit of what William Blake called " mental strife." It is true that a work of art remains a technical product, but it has an intellectual purpose to fulfil as well which only passion and imagination can achieve.

The practical objectivity of the Bauhaus teaching explains why, in spite of the diversity of its collaborators, its productions were characterised by a basic uniformity . . . . . .

In 1925 the Bauhaus migrated to Dessau, a move which coincided with an important change in its organisation. The dual control of each workshop by a teacher of design and a practical instructor was now superseded by that of a single master. In point of fact the fusion of their separate spheres had (as was hoped) been automatically effected in the course of training the first generation. Five old Bauhaus students were now chosen as heads of the new workshops.

In connection with the transference from Weimar the town council of Dessau commissioned me to design a comprehensive group of buildings: a new and ad hoc Bauhaus, a labour-exchange and a housing colony. For their construction and equipment I brought the whole body of teachers and students into active co-operation. The acid test of attempting to co-ordinate several different branches of design in the actual course of building proved entirely successful, and this without the self-sufficiency of its component parts suffering any prejudice. On the contrary, the effect on the individual pupil of transforming the school into a site for building operations was to increase his moral stature by virtue of the direct responsibility that now rested on him. The band of fellow-workers inspired by a common will and purpose I once dreamed of had become a reality and an example that could not fail to make itself felt in the outside world. In the period which followed several art schools and technical colleges at home and abroad adopted the Bauhaus curriculum as their pattern. German industry began to mass-produce Bauhaus models and to seek our collaboration in the design of new ones. Many former Bauhaus pupils obtained prominent positions in industrial concerns on account of their all-round training; others were appointed to teaching posts in foreign institutes. In short, the intellectual objective of the Bauhaus had been fully attained.

In 1928, when I felt that the stability and future of the Bauhaus were assured, I handed over control to my successor, and returned to practice in Berlin, where I could devote more of my time to the sociological and structural aspects of housing.....

My idea of the architect as a co-ordinator—whose business it is to unify the various formal, technical, social and economic problems that arise in connection with building—inevitably led me on step by step from study of the function of the house to that of the street; from the street to the town; and finally to the still vaster implications of regional and national planning.

I believe that the New Architecture is destined to dominate a far more comprehensive sphere than building means to-day; and that from the investigation of its details we shall advance towards an ever-wider and profounder conception of design as one great cognate whole—the mirror of the indivisibility and immensity and underlying unity of life itself, of which it is an integral part. It looks as though the mastery of the machine, the conquest of a new appreciation of space, and the pioneering work of finding the essential common denominator for the new forms of building had almost exhausted the creative powers of the architects of this generation. The next will accomplish that refinement of these forms which will lead to their generalisation.

But I must return to Town-Planning, at once the most burning and baffling problem of all.

The rapid increase in our means of locomotion, and the consequent readjustment of the old coefficient of time as the factor of distance, has begun to break down the frontiers between town and country. Modern men and women require contrast both as recreation and stimulus. The nostalgia of the town-dweller for the country and the countryman's for the town are the expression of a deep-rooted and growing desire that clamours for satisfaction. Technical developments are transplanting urban civilisation into the countryside and re-acclimatising nature in the heart of the city. The demand for more spacious, and above all greener and sunnier, cities has now become insistent. Its corollary is the separation of residential from industrial and commercial districts by the provision of properly co-ordinated transport services. Thus the goal of the modern town-planner should be to bring town and country into closer and closer relationship.....

The town—at once the embodiment of the corporate life of society and the symbol of its practical organisation—gives us the clue whence that reforming impulse arose which led to the emergence of the New Architecture. A critical examination of existing urban conditions began to throw new light on their causes. It was realised that the present plight of our cities was due to an alarmingly rapid increase of the kind of functional maladies to which it is only in the natural order of things for all ageing bodies to be subject; and that these disorders urgently called for drastic surgical treatment. Yet the most important international congress of town-planners in recent years ended in impotent shrugging of shoulders because the assembled experts had to admit they commanded insufficient public support to enable them to apply the necessary remedies. The only resignation we can possibly indulge in is that of knowing we have no choice in the matter. Once the evils which produce the chaotic disorganisation of our towns have been accurately diagnosed, and their endemic character demonstrated, we must see that they are permanently eradicated. The most propitious environment for propagating the New Architecture is obviously where a new way of thinking corresponding with it has already penetrated. It is only among intelligent professional and public-spirited circles that we can hope to arouse a determination to have done with the noxious anarchy of our towns. The technical means for

carrying that determination into practical effect are already at our disposal. Had our civic mentality been sufficiently ripe to appreciate it, we might now be reaping the benefit.

To sum up: the foundation of a flourishing modern school of architecture depends on the successful solution of a series of closely connected problems—the major issues of national planning, such as the readjustment of the relations between industry and agriculture and the re-distribution of population on rational economic and geo-political principles; a re-orientation of town-planning, based on a progressive loosening of the city's tightly-woven tissue of streets by the alternation of rural and urban zones and a more organic concatenation of the residential and working districts with their educational and creational centres; and, finally, the discovery of the ideal type of dwelling. The intellectual groundwork of a new architecture is already established. What, metaphorically speaking, might be described as the bench-tests of its components have now been completed. There remains the task of imbuing the community with a consciousness of it and its essential rightness: a task which will devolve upon the uprising generation.

No one who has explored the sources of the movement I have called the New Architecture can possibly subscribe to the claim that it is based on an anti-traditional obsession for mechanistic technique qua mechanistic technique, which blindly seeks to destroy all deeper national loyalties and is doomed to lead to the deification of pure materialism. The laws by which it seeks to restrict arbitrary caprice are the fruit of a most thorough and conscientious series of investigations. In these I am proud to have taken a share. . . . . .

The ethical necessity of the New Architecture can no longer be called in doubt. And the proof of this—if proof were still needed—is that in all countries Youth has been fired with its inspiration.

# TOWARDS A STANDARDISATION OF COLOUR NOTATION

By JOHN FASSLER

A standardisation of colour notation! What does this imply? Taking a parallel case for a moment, imagine a world without a unit of length, weight or currency. Commerce and industry would be unable to function, civilisation could not exist. Yet during the long period of man's development and through the successive phases of his cultures, colour has remained uncontrolled, a thing apart. The prerogative of the few colourists sensitive to its reactions. That past cultures produced no system can be understood when we consider, firstly, that their knowledge of the physics of colour was very limited, and secondly, that the volume of work required could be handled by the few artists with their assistant craftsmen. Since then, however, industry has assumed control of every phase of human requirements. The few colourists are no longer adequate to cope with the volume of work produced. To make matters worse, colour is being used to an increasing extent. A language of colour is urgently required. A language which in terms of symbols will define any possible known colour exactly. By means of symbols it will be possible to convey exact colour impressions to remote points. The designer will be able to concentrate his activities at one centre. His ideas transmitted in terms of colour symbolism will have the same significance everywhere. Accurate control at a distance becomes feasible. The advantages to both manufacturer and consumer are considerable. It will no longer be necessary to specify colour in terms of sample or vague description. The danger of error will be reduced to a minimum. Is such a finite system possible?

History shows that the standardisation of colour phenomena has received the attention of a number of eminent men. Newton was one of the first to formulate a working basis when he discovered the uni-dimensional arrangement to which material colour conforms. He produced the colour circle a fundamental form which persists to the present day, and though he contributed much his final conclusions lacked completeness. Research was carried on later by Mayer, Runge and Schopenhauer, and in fairly recent times by Young, Helmholtz, Hering and Manwell. Each contributed something to the groundwork of a feasible system, but all failed in the ultimate co-ordination of all colour phenomena. In 1909 Dr. Wilhelm Ostwald, of Leipzig, introduced his colour system. Based on an entirely different method of approach, the conclusions arrived at were consistently excellent. Ostwald realised early that the true interpretation of colour and colour harmony lay within the field of psychology, and not as was generally accepted within the field of physics. Such radical ideas brought him into immediate conflict with his fellow physicists. In spite of this, " Ostwald reduced the study of colour harmony to a mathematical table—to a series of laws which, when applied, can be guaranteed to produce the colours sought after by the artist. The eye is the chief testing rod, and sensation the principal measurement."*

This paper is an attempt to explain Dr. Ostwald's theory in as abbreviated a form as possible. The major points are dealt with and the sequence of the original has been adhered to.

*For a more detailed exposition see " Colour and Science," by Wilhelm Ostwald, published by Winsor and Newton, Limited, London.

## COLOUR STANDARDISATION.

In approaching the problem let us examine which factors limit or define distinctive colour values. Colour is the reaction of light on material substance, and therefore depends entirely on the behaviour of the incident light falling on any given material in question. It is surprising under these conditions that in spite of the infinite variability of this major factor under fluctuating daylight conditions, plus the adjustment of our visual organs, the colours of our surroundings exhibit such a remarkable degree of constancy. This stability is not due to our visual senses, but depends on the remission of light from material surfaces. Every substance rejects a certain definite fraction of the incident light, and if all the light is remitted and dispersed, that substance is conventionally called white, whether the substance be viewed at noon or dusk. The time factor can vary, but the fraction of the incident light which is remitted remains constant. Following a similar reasoning, a surface which remits no light is called black. A grey surface is one which reflects a certain uniform fraction of all luminous rays, while a chromatically coloured surface would remit different fractions of the different wavelengths forming the complex structure of light. All of these remitted rays are enclusive attributes of the substance to which the surface in question belongs. " We co-ordinate our colour sensations with experience and habit."

Proceeding further, consider the processes of vision enabling us to perceive the reactions postulated above. Vision, like all our perception of the senses, depends on a series of processes which occur successively in order to produce a result. A stimulus or form of energy is necessary to commence the process, and in the case of vision this is light. " Light is focussed through the lens into the terminal expansions of specially adapted nerve apparatus called the retina, giving rise to nerve currents which are transmitted to the brain, where additional and complex currents finally give rise to sensation. This sensation is directly coupled with consciousness." The sensitivity of the eye to rays falling on the retina has developed to such a degree that extremely minute amounts of energy suffice to produce nerve current. As a result the eye has achieved the valuable property of having a very small inertia. This sensitivity to minute stimulii determines the " limen " or " threshold value," which means that the change in stimulation must exceed a certain small but finite amount to be perceived. While the human eye developed in sensitivity it also acquired the capacity for distinguishing chromatic colour. This was an important step, as it immediately differentiated the human eye from that of many animals which, in spite of eye lenses, possessed neither the organs nor the capacity for correct colour vision. This ability to recognise colour was due to the development of new organs represented by a system of cone shaped structures lining the background of the visual cavity, that portion of the retina which is used by the optic lens for the formation of the sharpest images. The lateral area of the retina which supplements the general image is built up of simple organs called rods, and these are responsible for our lack of colour sense on the fringes of our field of view. It is significant that in the eyes of colour blind people and lower animals rods are the only structures found. As this optical evolution is comparatively new, it can be inferred that people lacking in colour consciousness are the result of an atavistic reversion to an earlier stage of development.

At this stage it is possible to co-ordinate the reactions of the eye with the fundamentals of colour. The standardisation will be arranged in the following stages:—

(a) Achromatic colours.
(b) Chromatic colours.
(c) Combination of achromatic with one or two chromatic colours.
(d) Complete co-ordination of all chromatic colours with achromatic colours.

## (a) ACHROMATIC COLOURS.

Black and white must be regarded as definite colours, as these are constant constituents of our visual field occurring just as often as red, green or blue, and, in addition, continually entering into combination with them. It is important that we must have a clear idea of black, white and grey, and to this end the following definitions must form our concepts of them.

(1) A white surface is one which remits the whole of the incident light, scattering it in every direction.

(2) A black surface is one which remits no light whatever.

(3) A neutral grey surface throws back the same fraction of all luminous rays.

Achromatic colours form a linear series having black and white as the extreme members, with a series of greys occupying the intermediate steps between them. There is no limit to the possible number of grey steps, but the threshold for differences of sensitivity limits the distinguishable number to form 300—400. Each of these intermediates can be measured in terms of an ideal white surface by means of a photometer, and according to this value every grey is distinguished numerically by its white content, that is by the fraction of white light which it rejects. All of these numerical values are proper fractions lying between zero and unity. Thus if w= the content of white and b= the content of black, then w + b=1 is constant for every grey. When w=o an ideal black surface results; when b=o an ideal white surface will result. In order to relate percentages of white to the equation given previously we must express a grey containing 25% of white as .25. This grey will also contain 75% of black and the equation w + b=1, that is .25 + .75=1 holds good.

It has been stated previously that the number of possible grey steps between white and black lies between 300—400. This number is too unwieldy. Simplification is required. As the decimal system works easily, assume a white content of 1.0, .9, .8, . . . . .1. The linear series embracing these ten steps must change evenly from step to step. To achieve this the reduction of white between steps 1 and .9 will be far less than that between steps .5 and .4, Figure (2) to produce visibly equal increment. The reason for this is to be found in Fechner's Law, which requires that if any series of stimuli be experienced in equal steps, then those stimuli must be arranged to form a geometric series. Thus if we wish to perceive a series of greys such that a is twice as grey as b and b is similarly twice as grey as c, then a b c must be arranged such that:—

see folding diagram p. 409

Log a=2 × log b and

Log b=2 × log c.

In terms of this law the values representing the steps adopted must be the logarithms of the true values of white in each case. Referring back to the original decimal series given, that is:—

1.0, .9, .8, .7, .6, .5, .4, .3, .2, .1 these in terms of the law given must be the logarithms of the true values of white. To obtain these take the anti-logarithms of the value given above so that the following series results:—

1.00, 0.79, 0.63, 0.50, 0.40, 0.32, 0.25, 0.20, 0.16, 0.126, and since we have arranged that .25=25% white. The corresponding percentages in terms of the above series will be:—

100, 79, 63, 50, 40, 32, 25, 20, 16, 12.6.
a c e g i l n p r t.

If under each of these values we place the symbols shown, we then have a graded scale of greys whose constituents can be postulated. Reducing the scale still further to bring it within the range of memory, we have:—

a . c . e . g . i . l . n . p . Figure (1).

This forms the standard achromatic scale for greys, black and white. The steps can be easily recognised and each of them represents a definite measurable quantity of black and white.

Note: The final figures arrived at by Ostwald, making allowances for practical considerations in producing ideal black and white, are:—

| a | c | e | g | i | l | n | p. |
|---|---|---|---|---|---|---|---|
| 89 | 56 | 35 | 22 | 14 | 8.9 | 5.6 | 3.5. |

The above values represent percentages of white.

## (b) CHROMATIC COLOURS.

Chromatic colours next to achromatic colours form the second and larger part of the colour field. While the entire series of achromatic colours may be built up from black and white, pure colours, or hues, must have no perceptible mixture of these, the word mixture having a psychological, and not physical significance. When light was first split up into its constituent colours the natural sequence of the different hues gave a clue to the linear or unidimensional arrangement to which material colour conforms. Figure (3). Since the time of Newton this idea has persevered and pure colours are regarded as being capable of continuous arrangement in the form of a circle or closed line. In the case of achromatic colours the linear series is limited by two definite points, black and white, but in the continuous circular arrangement of pure colours, these from points of maximum difference approach each other. By selecting a suitable number of pure colours, and placing them round the circumference of a circle, points of maximum difference will occur diametrically opposite each other. Psychologically we distinguish four fundamental colours: Yellow, red, blue and green. Figure (4). As this number is not sufficient, we must include intermediate hues such as orange, purple, etc., to expand the total to eight. These eight colours can be placed round the circumference of a circle, but the differences between each of them will be sharply defined. To improve the flow of the sequence further intermediates must be added. The most convenient arrangement requires the addition of two variations of each hue, one on each side, thus increasing the total to 24. All differences will be within the threshold and will be easily distinguishable.

Any successful sub-division must assign complementary colours to opposite points of the circle. The arrangement formulated withstands the test perfectly. Earlier colour theories designate the contrast of red as leaf green. The present system shows that the contrast of leaf green is purple. This is backed up by Schopenhauer, who proved this fact experimentally by the study of after images. The standard circle of pure hues does not classify mixtures of these colours. If any two are mixed the result will be a third colour + grey. The more widely the colours are separated the more grey will be present until ultimately taking two colours diametrically opposite each other, that is complementaries, the result will be pure grey if the colours are mixed in the correct proportions.

At this stage the standardisation provides for a correct arrangement of achromatic colours, a standard circle of pure colours. The next phase, the combination of pure colour with black and white, is more complex and presents far more difficulties. Dr. Ostwald has neatly overcome all obstacles.

### (c) ACHROMATIC COLOUR + ONE OR TWO CHROMATIC COLOURS.

For the complete definition of any colour we must know not only its hue in terms of the standard circle, but also its content of black and white. Maxwell showed that all colour mixture equations are linear, and off the first degree, and from this Ostwald deduced the equation $c + w + b = 1$ where $c$ = the amount of full colour, $w$ = the amount of white and $b$ = the amount of black. That is the sum of the parts is always equal to a constant. The above equation can be represented by an equilateral triangle with side equal to the constant such that $a\,c + b\,c + c\,d = 1$ (Figure 5) which is true for all points in the triangle. If a c, b c and c d are called C, W and B respectively, then we have $C + W + B = 1$, which is the colour equation given above. All points in the triangle therefore indicate an infinite number of mixtures of a given colour with black and white.

The side W B will consist of the achromatic series, a, c, e, g, i, l, n, p, as deduced previously; the angle C will contain the pure colour, the side C W mixtures of white with the colour, and the side C B mixtures of black with the pure colour. All combinations in which black and white join will fill the interior of the triangle. In the triangle itself three systems of lines parallel to the respective sides have special significance. These are (Figure 5):—

(1) All lines parallel to CB represent colours having equal amounts of white. These are consequently called Isotints.

(2) All lines parallel to CW represent colours having equal amounts of black. These are consequently called Isotones.

(3) All lines parallel to WB represent colours having equal amounts of pure colour. These are consequently called Isochromes.

The reduction of the triangle into measurable quantities is the next consideration. If we divide the side WB into the achromatic series worked out in the first portion of this standardisation, representing quantity in terms of length, the side of the triangle would be divided up unequally (Figure 5). If, in addition, we set out a similar series for W and C along WC, and another for B and C along BC, then every side would be divided differently, with the result that it would be impossible to obtain any kind of relation between the three factors.

Approaching the problem from a slightly different angle, we must realise that each of the sides WB, CB, CW represent colour series which become darker, lighter or richer in colour in visibly increasing increments. Each of the increments is equal. This fact immediately relates the factors to one common law. Fechner's Law, which indicates that in order to obtain the equal increments we require, we must take the logarithms of the quantities concerned and set these out along the sides of the triangle. A logarithmic triangle is thus formed containing a series of rhomboids representing all possible mixtures of a colour with white and black. Ostwald finally defines this arrangement as a monochromatic triangle (Figure 5). An inflexible system of symbols is next required.

If along the side containing the achromatic series we use the symbols a, c, e, g, i, l, n, p, and then mark each remaining space with the letters of the two grey axes which cross in them, remembering always to place the undermost letter first, then mark the colour panel with the number of that hue in the colour circle; we have a triple system of symbols consisting of one number and two letters which not only define the colour, but give its percentages of white, black and pure colour. In the words of Ostwald: "These colour symbols are of the greatest importance. They render it possible for all standard colours to be marked in an absolutely non-interchangeable and unalterable manner, with the same accuracy that pitch is given by musical notes. They are necessarily more complicated than these notes because the varieties of musical pitch form only a linear group, while the colour group is threefold."

## (d) COMPLETE CO-ORDINATION OF ALL CHROMATIC COLOURS WITH ACHROMATIC COLOURS.

The complete integration of all colours with black and white can be accomplished by taking a logarithmic triangle, holding this so that the achromatic side forms a vertical axis, and then rotating the triangle in space. The vertical axis will remain fixed, but the main body will define a volume which will be a double cone. The pure colours will lie on the equator of this solid, with white at the top apex, and black at the bottom. Divide the equator, which is a circle, into the twenty-four standard colours. We will then have a colour solid (Figure 6). This completely defines all relations of pure colour, black and white. On its upper surface are situated all the Isotints, on its under surface all the Isotones; all the dulled or broken colours occupy the interior, the paler broken colours being zoned near the upper apex, the darker broken colours near the lower apex. The deeper and purer broken colours will lie near the circumference. Assuming that the original logarithmic triangle was divided up into its Isotones and Isotints; these, when revolved, would trace out 28 independent colour circles rhombic in cross section, each of which would become a colour circle containing the twenty-four standard hues. These secondary colour circles or rings have a special significance as they represent colours with the same amount of black and white, and are therefore called isovalent colours. The isovalent colour circles are important in that they represent colours which show a particularly close relationship to each other. This relationship is usually referred to as colours having equal value.

The advantage of this system to architects lies in the possibility of being able to specify colour exactly. There is nothing more exasperating than to attempt an explanation of a particular colour, to either a painter or furniture manufacturer. These men are not at fault; each of them follows his own ideas of colour interpretation. As a result the successful completion of any colour arrangement is due either to the architect's impatient persistence, or to chance favouring the mixing in the painter's pot. To write on an interior sketch: colour of walls, 2 e a; colour of ceiling, white; colour of doors, 5 p c; colour of curved wall, 15 i c, and know that without even going near the site these values would be translated exactly, is an ideal to which everyone who regards colour application seriously would subscribe. The system is ready. Industrial inertia prohibits its adoption.

We reprint a report on one of the items of the Congress of South African Architects recently held in Johannesburg, reference to which is made in our correspondence columns.

At the Conference of South African Architects . . . . . further discussion on the advisability or otherwise of pressing for the amendment of the Act so as to secure the inclusion of Clause C (3) emphasised the fact that such an amendment would entail throwing the profession open to unregistered persons who were now making a living as so-called architects. It was felt that this aspect of the matter especially concerned young practitioners who had become qualified for registration by virtue of university qualification.

In view of the importance of the matter, and the danger of arriving at an overhasty decision to press or not to press the amendment of the Act, it was decided to postpone the issue till a later stage of the congress.

## DIVERGENT VIEWS.

The subject of architectural education was discussed in a paper prepared by Mr. F. K. Kendall, F.R.I.B.A., M.I.A., of Capetown. He emphasised that every university course should keep in touch with the profession as closely as possible, taking every reasonable opportunity of outside collaboration.

" I think it must be patent to all of us," said Mr. Kendall, " that the profession as a whole is sadly lacking in homogeneity—to the extent that amongst practising architects there is divergence even as to the aim of an architect when setting about his work, whether it is art, science, or pure business. The very target for one is so much different from that of another. Moreover, the many different types of modern buildings automatically breed different types of legitimate specialists within the ranks. The field was so wide that it was well nigh impossible to secure unanimity of opinion on some of the fundamental principles.

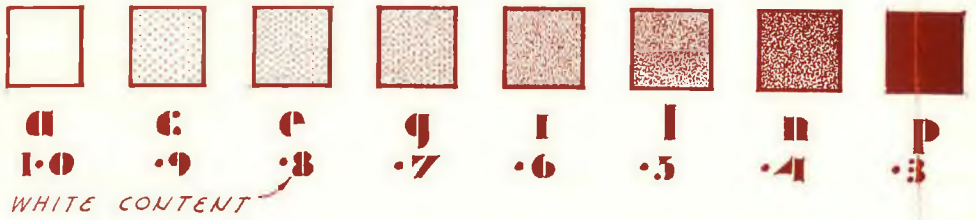
## A WARNING.

" So long as we can improve on old methods, we are justified in doing so. The fatal mistake is in assuming that every change from tradition is necessarily an advancement—and I would hold up a warning finger in particular to the rising generation to exercise their discrimination very warily. A revolution may carry all before it in the heat of the battle—but when results are counted in the cool deliberation of the morrow, it is found that much needless and wanton destruction has taken place which saner moments would never have permitted. Aesthetically speaking, I firmly believe that in a few years' time many of our most modern buildings will be the first to be regarded as obsolete monstrosities. Some materials and methods are untried—quite experimental—and will fail in the acid test of experience. Students should not be encouraged to run wild in this elusive field of modernism. They should not be allowed to think that ' The Modernist ' is a developed style. They must not think that all the ' short cuts ' it permits are going to serve them always. Any so-called architectural style in history has taken centuries to develop; and, even allowing for a quicker moving world to-day, we must not pin our faith to mob law. It must be evolution, not revolution. No matter to what advanced stage modernism may be developed, an intimiate knowledge of the styles of the past remain the A.B.C. of an accomplished architect's education."

From the " Star."

UNFOLD!

## ① achromatic colours



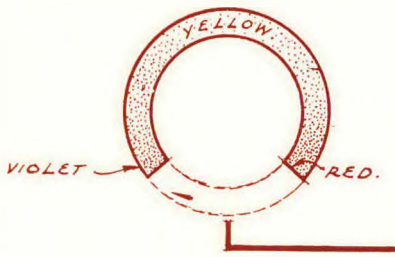

## ② 

AMOUNT OF BLACK ADDED BETWEEN 1·0 AND ·9 ═

AMOUNT OF BLACK ADDED BETWEEN ·5 AND ·4. ═

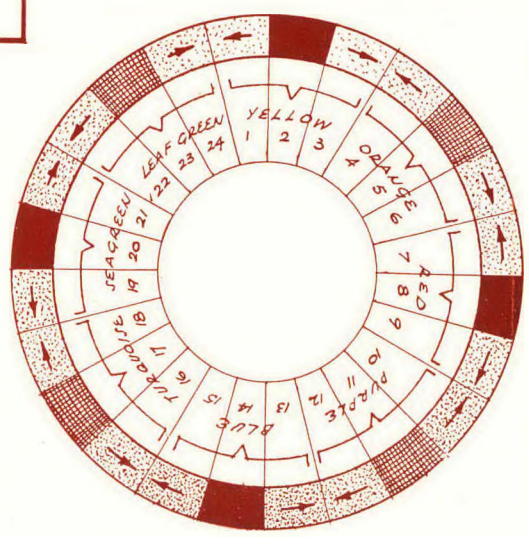
## ③ chromatic colour


SPECTRUM OF WHITE LIGHT.
THIS SHOWS THE LINEAR ARRANGEMENT TO WHICH MATERIAL COLOUR CONFORMS CONSEQUENTLY THIS BAND CAN BE BENT ROUND.



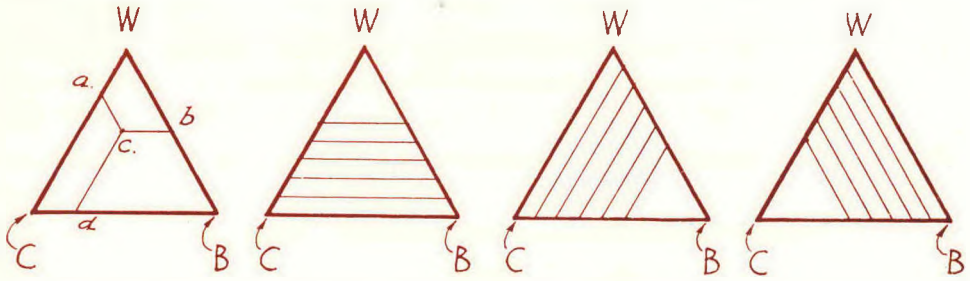

TO COMPLETE THE COLOUR CIRCLE AND MAKE CONTINUOUS TRANS-ITIONS FROM YELLOW TO VIOLET POSSIBLE EITHER THROUGH ORANGE AND RED OR GREEN AND BLUE, THE GAP SHOWN MUST BE FILLED IN WITH A SERIES OF GRADED PURPLES

## ④ colour circle

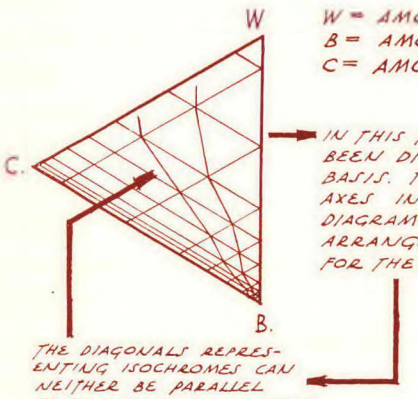



THE FOUR FUNDAMENTAL COLOURS WE DISTINGUISH SHOWN IN BLACK ARE YELLOW, RED, BLUE, AND GREEN. THE FOUR INTER-MEDIATE COLOURS REQUIRED TO ASSIST THE TRANSITION ARE ORANGE, PURPLE, TURQUOISE, AND LEAF GREEN. THESE ARE SHOWN HATCHED EACH COLOUR HAS TWO VARIATIONS BESIDES ITSELF. THE BIAS OF THESE IS INDICATED BY THE ARROWS.

## ⑤ achromatic + chromatic colour

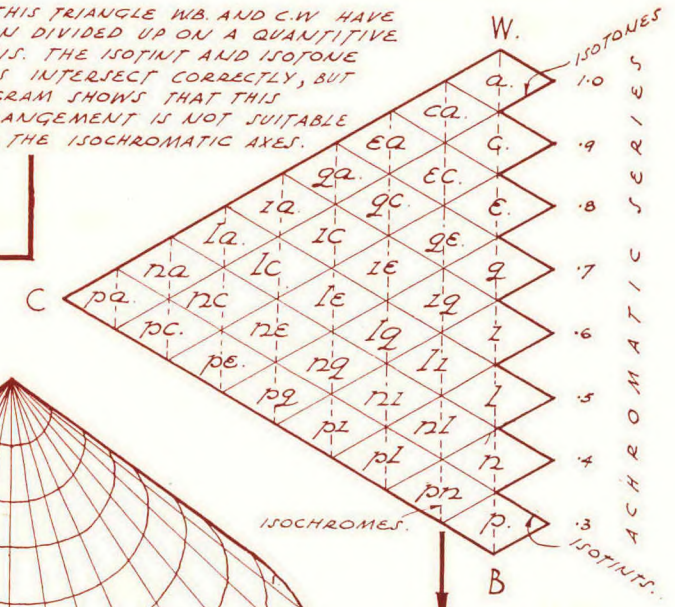



W = AMOUNT OF WHITE.
B = AMOUNT OF BLACK.
C = AMOUNT OF PURE COLOUR.

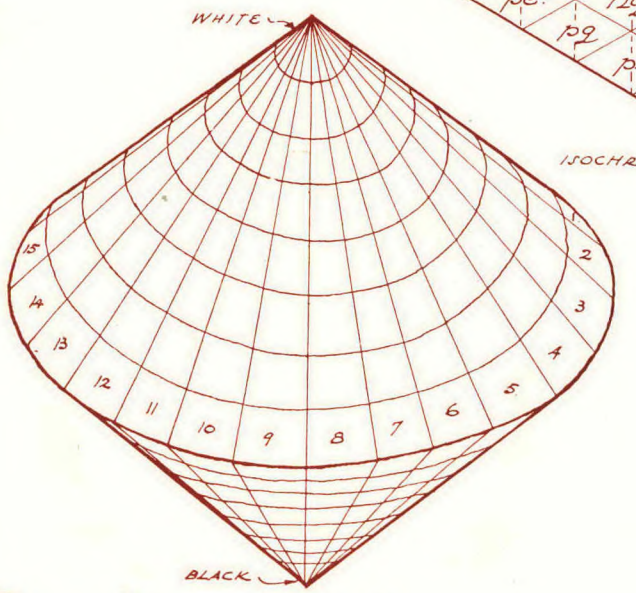



IN THIS TRIANGLE WB. AND C.W HAVE BEEN DIVIDED UP ON A QUANTITIVE BASIS. THE ISOTINT AND ISOTONE AXES INTERSECT CORRECTLY, BUT DIAGRAM SHOWS THAT THIS ARRANGEMENT IS NOT SUITABLE FOR THE ISOCHROMATIC AXES.

THE DIAGONALS REPRES-ENTING ISOCHROMES CAN NEITHER BE PARALLEL TO W·B· NOR BE STRAIGHT LINES.




IN THE ABOVE TRIANGLE THE SIDES WC·CB·BW HAVE BEEN DIVIDED UP ON A LOGARITHMIC BASIS. THE AXES INTERSECT CORRECTLY DIVIDING THE INTERIOR INTO AN EVEN SERIES OF RHOMBOIDS. EACH RHOMBOID REPRESENTS A MIXTURE OF. C+W+B.




## ⑥ colour solid

## CORRESPONDENCE

The Editors,
South African Architectural Record.

Sirs,

There was published in the " Star " of Tuesday last a partial report of a paper prepared by Mr. F. K. Kendall, on the subject of architectural education. This paper was submitted to a sitting of the Second Congress of the Institute of South African Architects, and was replied to in some detail by Professor Pearse, of the University of the Witwatersrand, and, in addition, commented on by other delegates present. A section of that paper has been selected in the report dealing in particular with a warning to the rising generation of architects. As no mention is made of the replies given at the Congress, I deem it advisable to put forward the feeling of the younger architects on the points contained in Mr. Kendall's warning.

I must emphasise, in the first place, that architects in the contemporary field approach the subject of their art with an absolute sincerity of purpose, and in the belief that only by deep study and a comprehensive and broad outlook can they achieve the high ideals to which they aspire. They claim that theirs is not a " change from tradition," but a continuance, in the highest sense, of that tradition. The approach that a true understanding of this historical background gives is widened to embrace the problems of a new age. " Discrimination," therefore, is a word ill applied to intelligent research in these vital matters. Mr. Kendall's statement that what he is pleased to call " our most modern buildings " (assuming that he refers to those which show a definite attempt at a solution of some fundamental contemporary problem) will be " the first to be regarded as obsolete monstrosities " is nothing short of amazing. This view, on face value, might indeed constitute a grave indictment of modern architectural endeavour, but is Mr. Kendall serious in maintaining that some inane false and distorted version of what is supposed to represent our great architectural heritage may yet overhaul in permanence of value a congruous and deliberate solution based on the essentials as given, created with a due consideration of our immensely complex sociological background? New materials and new structural methods cannot be airily dismissed merely on the ground that they are experimental—experiment is the very essence of progress. To dogmatically state that they will fail is to display a lamentable spirit of obstructionism.

As for our students, here we find on examination that there is no " running wild in this elusive field of modernism." On the contrary, their development is most carefully planned on an

admirably conceived system of historical research. What they acquire is the classical approach—an understanding of the equipment in both the spiritual and material sense, with which the great imitators of the past came to their architectural problems. Mr. Kendall refers to the "short cuts" that the "Modernist Style" allows. A true understanding of the immense task faced by the architect of to-day must surely convince even the most conservative that no such "short cut" is possible. An exacting life work, on the contrary, is what the serious contemporary architect offers to society.

But Mr. Kendall, in spite of his many critical digressions, does finally concede at least a development to "modernism." He qualifies that concession by stating that, nevertheless, "an intimate knowledge of the styles of the past must remain the A.B.C. of an accomplished architect's education." I grant the "knowledge," but dispute the value of such knowledge except in the broad sense I have shown in the practical solution of our urgent modern architectural problems. Finally, I must add that we owe to the present, at least the same tribute of thought and study that we give so willingly to the past. We are creating an epoch—a significant historical future that holds no less than the greatest of the past forms significant in art and so in life.

N.H.

## PROFESSIONAL NOTES AND NEWS

### Entries in Classified Section—Transvaal Telephone Directory.

The following letter from the Manager, Publicity Department, is published for the information of members:—

> I have to advise you that in accordance with the conditions as set out on pages Nos. 365 and 535 of the October issue of the above-named publication, entries in the Classified Sections will only be permitted on payment of 5/- per entry per issue in either the English or Afrikaans Sections, or 10/- for both Sections as and from the April, 1937, issue.

### TO ALL OUR READERS

The President, Members of the Board, and the Secretary, send to Members of the Chapter and the Institute, Hearty Christmas Greetings and Best Wishes for a Prosperous New Year.

The President-in-Chief (H. J. Brownlee, Esq.), Members of the Central Council, and the Registrar, send to Members of the Institute and the Chapter, Hearty Christmas Greetings and Best Wishes for a Prosperous New Year.

The President and Committee of the Transvaal Provincial Institute of South African Architects send Greetings and Best Wishes for Christmas and the New Year.